(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 April 2002 (04.04.2002)

PCT

(10) International Publication Number
WO 02/27708 A2

(51) International Patent Classification[7]: G10L

(21) International Application Number: PCT/US01/29911

(22) International Filing Date: 25 September 2001 (25.09.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/668,306 25 September 2000 (25.09.2000) US

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
without international search report and to be republished upon receipt of that report

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WO 02/27708 A2

(54) Title: CALL PROCESSING SYSTEM WITH INTERACTIVE VOICE RESPONSE

(57) Abstract: A call processing system has an architecture that provides interactive voice response to callers before further routing of calls. Ports connected to the telephone network are coupled to processors that perform interactive voice response without a distributive switch therebetween. Redundancy is provided at component and system level and an uniterruptible power supply and transfer panel are connected to a supplemental generator. Local call processing systems are connected by multiple networks to remote call processing systems with a redundant distributed database accessible to the processors and resource servers for providing other services, such as text-to-speech and speech recognition. A resource management unit detects, stores and reports resources available on each system to higher level call processing systems connected via the network. Addresses of call processing systems at least at higher levels are accessible by a local call processing system for redundancy.

CALL PROCESSING SYSTEM WITH INTERACTIVE VOICE RESPONSE

FIELD OF THE INVENTION

The present invention relates to a call processing system and, more particularly, to a call processing system that provides interactive voice response.

DESCRIPTION OF THE RELATED ART

Interactive voice response (IVR) systems are commonly used to automate the process of obtaining and providing information to users. Usually an IVR system interacts with the user via the dual-tone multi-frequency (DTMF) keypad on the user's telephone for input and the telephone speaker for output. Often, the IVR system is part of a larger system that provides other services, such as outdialing, text-to-speech conversion, speech recognition, etc. However, all known combined systems have an architecture that treats the IVR system like all of the other systems.

A typical combined system is disclosed in U.S. Patent 5,884,032 to Bateman et al. which is connected to the public switched telephone network (PSTN) via a digital switch that is also connected to a data network to which all of the various types of systems, including the IVR system are connected. Often, the digital switch is controlled by an automated call distribution (ACD) system that attempts to route the call to the appropriate subsystem based on routing information, such as the number that was called to reach the system, provided by, e.g., dialed number identification service (DNIS), or the number from which the call was initiated, e.g., automatic number identification (ANI). However, often this is insufficient information to make a final determination of how the caller will be serviced by the call processing system. Therefore, calls end up being re-routed from subsystem to subsystem while being connected to the switch.

Furthermore, a typical call processing system is not easily scalable or able to overcome failure of key components. Part of the problem is that such systems are typically centered on the digital telecommunications switch. Another part of the problem is that the architecture of such systems generally does not have high level redundancy. There may be redundant components within the system but there is now known call processing system with an IVR that has wide area redundant capabilities.

SUMMARY OF THE INVENTION

An object of the present junction is to initially provide interactive voice response to incoming calls for rerouting calls when necessary.

Yet another object of the present invention is to provide a call processing system with high redundancy that is able to continue to process incoming calls despite failure of major components.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a prior art call processing system.

Fig. 2 is a block diagram of a local call processing system according to the present invention.

Fig. 3 is a block diagram of power supply for a local call processing system according to the present invention.

Fig. 4 is a distributed call processing system according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A simplified example of a conventional call processing system is illustrated in Fig. 1. A private branch exchange (PBX) 20 is connected to the PSTN 22 via numerous connection 24, such as one or more T1 lines or analog telephone lines (POTS). PBX 20 includes a conventional automatic call distributor (ACD) 26 for distributing calls internally to human operators represented by desktop computer systems 28 and IVR system 30. Information systems and databases 32 are accessible by PBX 20 and the desktop systems 28 for information to distribute calls by ACD 26 and provide or store information related to callers by the human operators.

There are numerous draw backs to conventional systems. First, conventional call processing systems of the type illustrated in Fig. 1 typically use

propriety hardware and software that is quite expensive compared to the component cost. As a result, maintenance and upgrades are expensive. Conventional systems were designed for a single site and thus, multi-site configurations require an additional layer of hardware and software that was not part of the original design, making multi-site expansion expensive and difficult. Not only were multi-site configurations designed later, but many other services, such as speech recognition, were not part of the original design of a conventional PBX 20 and inclusion of such capability reduces the number of lines available for IVR system 30 as well as adding further complexities to the system architecture.

Illustrated in Fig. 2 is a block diagram of a first embodiment of a call processing system 38 according to the present invention. Instead of using a PBX to provide services that were not contemplated during the design of the PBX, the present invention utilizes call processing unit 40 designed for flexibility, efficiency, and scalability. Call processing unit 40 is connected to PSTN 22 via a PSTN interface 42 and to an internal communication interface 44. In the preferred embodiment, call processing unit 40 includes a plurality of digital signal processor (DSP) cards 46, that provide at least IVR and thus may be referred to as IVR servers. Each DSP card 46 is capable of handling, e.g., 24 telephone calls simultaneously, i.e., a telephone connection provided by a T1 line, such as a Dialogic D480 SC-2T1 card available from Dialogic Corporation of Parsippany, New Jersey. A typical system may have up to 20 such processor cards 46. Internal communication interface 44 may be an Ethernet LAN switch/hub, having sufficient capacity to communicate with DSP cards 46 via e.g., a 100 Mbps connection.

Preferably, internal communication interface 44 is connected to computers that act as servers for other functions. For example, database server 48, such as a Compaq Proliant 1600 running SCO Unixware 2.x, accesses database 50, such as Oracle 7.3, for information required by processing cards 46 to provide programs and data used in the interactive voice response process and information used by human operators in communicating with callers. In addition, webserver 52 may be provided for update of the information in database 50, by one or more information providers, or to provide access to that information by users as an alternative to calling on the telephone.

Each processor card 46 typically has 24 ports (for 24 calls) with a DSP connected to each port. Each DSP is programmed to begin the IVR process with the caller when a call is received and is capable of outdialing operations, such as for predictive dialing. As the call progresses, additional data or functional

capabilities are requested by the DSP via internal communication interface 44 from database server 48 or other resource servers 54. In addition to IVR, the DSPs in processor cards 46 may be programmed to provide text to speech. Alternatively, separate text-to-speech cards, such as Antares 2000/50, from Dialogic Corporation with software from Lernout & Hauspie of Burlington, Massachusetts, may be used and coupled to the caller via LAN/WAN 56 and the processor cards 46.

If the program executed by the DSP, receives a response from the caller that requires assistance of resources that are not available at call processing system 38, the DSP requests that a human operator be called, or the caller be switched to another call processing unit 40 at a different location, as discussed below in more detail. The DSPs in processor cards 46 are programmed to route callers to another call processing unit 40 via network call routing by identifying a called number at which an human operator or another call processing unit can be connected to assist the caller using a second port to outdial to the called number and bridging the caller on the first part to the second part.

Web server 52 provides access to database 50 to update the database and may also be used as an alternative to telephone calls by users. Call processing unit 40 also has access to resource servers 54 to obtain e-mail messages, *transcription (speech-to-text) of messages* left by callers via call processing unit 40, unified messaging, conference calling, or communicating by other means. In addition, processor cards 46 are capable of outdialing operations and may be accessed by resource servers 54 for sending facsimile forms or digital auto files requested callers, either to a facsimile number provided by the user, the same number the user called from, a number obtained from database 50, or, particularly in the case of audio files, directly to the user while still connected. In addition, outdialing capabilities of call processing unit 40 may be used by resource servers 54 for broadcasting voice messaging, paging, broadcasting facsimile etc. In addition to accessing local database 50 via database server 48, requests can be made via LAN/WAN 56 to other databases.

The service provided to callers is preferably monitored by call processing unit 40 with statistics sent to database 50, or a monitoring and reporting server included in resource servers 54. The information monitored may include information such as length of time that the caller interacts with the IVR, length of time between receipt of a callers response and the beginning of output in response thereto, total time of connection, the length of time that network call routing is performed (i.e., that a caller is bridged to a called party) and the type of interactive

voice response performed. One of the advantages of bridging callers to human operators (or other call processing systems) at a remote terminal is that the caller can be returned to call processing unit 40 for further IVR processing or other services after the remote connection is broken by the remote terminal.

Preferably call processing unit 40, internal communication interface 44 and servers 48, 52, 54 are all constructed using conventional redundant capability for maximum reliability. For example, call processing unit 40 preferably includes the ability to "hot swap" processor cards 46, when a single card has a fault. To ensure that no DSP(s) are servicing callers when a card is swapped out, call processing unit 40 further includes resource management unit 60 for allocating resources, including the ability to restrict subsequent calls from being routed to a particular processor card 46, by taking all DSPs on a processor card 46 out of service and reporting to a system operator when the processor card 46 is not handling any calls.

To ensure maximum reliability, power is preferably supplied to the components illustrated in Fig. 2 using a power architecture as illustrated in Fig. 3. In addition to obtaining power from a commercial utility 70, an on-site supplemental generator 72 is coupled via transfer panel 74 through an uninterruptible power supply 76 to alternating current (AC) powered equipment 78. UPS 76 maintains power in a conventional manner for sufficient time for resource management unit 60 or another component connected to the network to start operation of generator 72. In addition, a system operator may be informed of the power interruption, e.g., via an outdialing operation. In a typical embodiment, there is direct current (DC) powered equipment 80, such as multiplexers, patch panels and routers, as well as AC powered equipment 78. Therefore, transfer panel 74 is also connected to AC/DC Rectifier 82 and battery 84 to ensure that there is no power interruption to DC powered equipment 80.

In addition to managing local resources, resource management unit 60 provides the capability of easily configuring a call processing system over a widely dispersed geographic area. Thus, database 50 preferably is capable of being part of a distributed database schematically illustrated in Fig. 4. Communication between database servers 48 is preferably provided by LAN/WAN 56. By dispersing the locations of call processing systems throughout a region served, there is greater security from natural disasters and manmade disruptions to service. It is also possible to provide economy of telephone service by locating call processing systems in areas of highest use. Distribution of data can be

accomplished using conventional distributed database techniques to ensure redundant, up-to-date copies of the database at each location.

To provide flexibility of call processing functions, a hierarchical organization of call processing systems 38 is used. Preferably, multiple communication trunks are available for communication between the resource management units 60. The wide area network represented by LAN/WAN 56 may be provided by one or more leased lines. In addition, data communication between resource management units 60 may be accomplished using the PSTN 22 which preferably includes a plurality of long distance carriers having separate physical connections to PSTN interface 42.

When, for example, a processing card 46 is replaced as described above, resource management unit 60 detects the presence of the new processing card 46 and registers the additional resources as available in database 50, or elsewhere. In addition, the updated resource capabilities are reported to a higher level call processing system. Address(es) for contacting the higher level call processing system are retrieved (or input) at start up of a call processing system 38. For example, call processing system 38A in Fig. 4 may be a primary call processing system which receives reports from call processing systems 38B and 38C regarding total resources and resources in use. There may be separate call processing systems 38 at a single geographical location, in which case resource status is first reported via a hierarchy of co-located call processing systems 38 and then to a higher level call processing system at a remote location. Between any particular level, there may be only a single lower level and single higher level call processing system and there may be any number of levels. Preferably, the top level is redundant, or at least the address and hierarchical structure is stored in the redundant distributed database, so that if no response is received from an immediately higher level call processing center, that call processing can be leap-frogged by lower levels to a higher level, or if the highest level is non-responsive, a second level call processing system takes over, until a response is received.

The communication between resource management units 60 is not limited to providing redundancy. Callers may be shifted from one call processing system 38 to another based on schedule or capacity. Examples of schedules include expected volume for time of day, local holidays, etc. Examples of shifting callers based on capacity include high resource use, or lack of a required resource at a particular call processing system. One way of implementing such shifts is to include in each call processing system a load balancer for balancing usage of the

long distance carriers by outgoing calls, e.g., when bridging to a called party or contacting a remote call processing system, or performing an outdialing operation for any of the services that require outdialing.

The many features and advantages of the present invention are apparent from the detailed specification and thus, it is intended by the appended claims to cover all such features and advantages of the system which fall within the true spirit and scope of the invention. Further, numerous modifications and changes will readily occur to those skilled in the art from the disclosure of this invention. It is not desired to limit the invention to the exact construction and operation illustrated and described; accordingly, suitable modification and equivalents may be resorted to, as falling within the scope and spirit of the invention.

CLAIMS

What is claimed is:

1. An interactive voice response system connected to a telephone network, comprising:

ports connected to the telephone network to receive calls therefrom; and

processors, connected to said ports without a distributive switch therebetween, to provide interactive voice response to callers.

2. An interactive voice response system as recited in claim 1, wherein said processors further monitor length of calls from when the callers are connected until the callers disconnect.

3. An interactive voice response system as recited in claim 1,

wherein said processors are provided by at least one interactive voice response server, and

further comprising a plurality of resource servers coupled to said at least one interactive voice response server.

4. An interactive voice response system as recited in claim 3, wherein said resource servers include at least one text-to-speech server and at least one speech recognition server.

5. An interactive voice response system as recited in claim 4, wherein said resource servers include at least one data access server to access at least one local database and a web server to provide remote access to the at least one database.

6. An interactive voice response system as recited in claim 5, wherein said resource servers further include at least one server providing call routing, predictive dialing and qualified calling.

7. An interactive voice response system as recited in claim 6, wherein said resource servers further include at least one server providing at least one of voice

mail, voice broadcast, facsimile broadcast, facsimile messaging, unified messaging, and conference calling.

8. An interactive voice response system as recited in claim 5,

wherein said interactive voice response system provides services on behalf of a plurality of information providers, and

wherein said web server provides access to the information providers to update the at least one database.

9. An interactive voice response system as recited in claim 8,

wherein said interactive voice response server further performs network call routing by bridging a caller on a first port to called party on a second port after outdialing using the second port, and

wherein said web server provides access to the at least one database by the called party.

10. An interactive voice response system as recited in claim 7,

wherein said interactive voice response server further performs network call routing by bridging a caller on a first port to called party on a second port after outdialing using the second port, and

wherein said web server provides access to the at least one database by the called party.

11. An interactive voice response system as recited in claim 7, wherein said at least one database includes at least one of a local database stored on said at least one database server and a remote database coupled to said database server via a long distance data network.

12. An interactive voice response system as recited in claim 1, wherein each of said processors is connected to two of said ports and further performs network call routing by bridging a caller on a first port to a called terminal on a second port after outdialing using the second port.

13. An interactive voice response system as recited in claim 12, wherein said processors further monitor length of the calls and time required to perform operations.

14. An interactive voice response system as recited in claim 13, wherein the length of the calls monitored by said processors include length of time that the caller is connected by the bridging between the first and second ports.

15. An interactive voice response system as recited in claim 14, wherein said processors perform at least one of interactive voice response and network call routing after bridging is terminated by the called terminal and the caller remains connected.

16. An interactive voice response system as recited in claim 14, wherein said processors store information on at least one of the length of time that calls are connected to the called terminal, the length of time that interactive voice response is performed, the length of time that network call routing is performed and type of interactive voice response performed.

17. An interactive voice response system as recited in claim 1, wherein said processors are provided by a plurality of call processing systems coupled together hierarchically, each call processing system including a plurality of interconnected interactive voice response servers, resource servers and a resource management server to access said resource servers and any of said interactive voice response servers available at a lower level and issuing resource requests to a higher level when lower level resources are unavailable.

18. An interactive voice response system as recited in claim 17, wherein said interactive voice response servers at each level register with at least one resource management server at a higher level to identify the lower level resources available thereto.

19. An interactive voice response system as recited in claim 18,

wherein in each call processing system said resource and interactive response servers register with said resource management server as resources that are available, busy or out of service, and

wherein said resource management server assigns available resources in response to requests for required resources.

20. An interactive voice response system as recited in claim 17,

wherein said ports are connected to a plurality of long distance carriers, and

wherein each call processing system includes at least one load balancer for balancing usage of the long distance carriers by outgoing calls.

21. An interactive voice response system as recited in claim 17, wherein the resource management server in each of said call processing systems at higher levels allocates resources on a lowest cost basis.

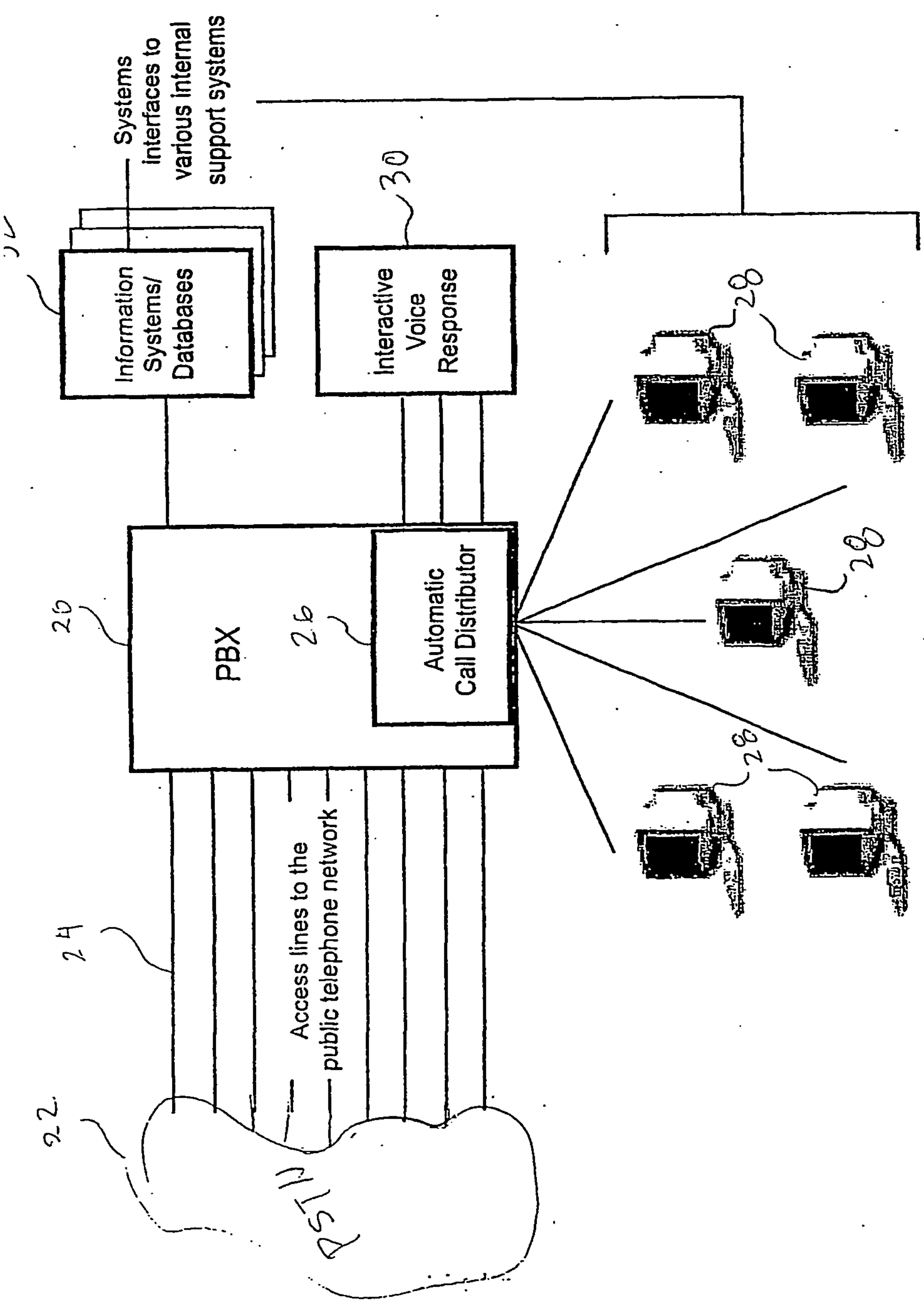
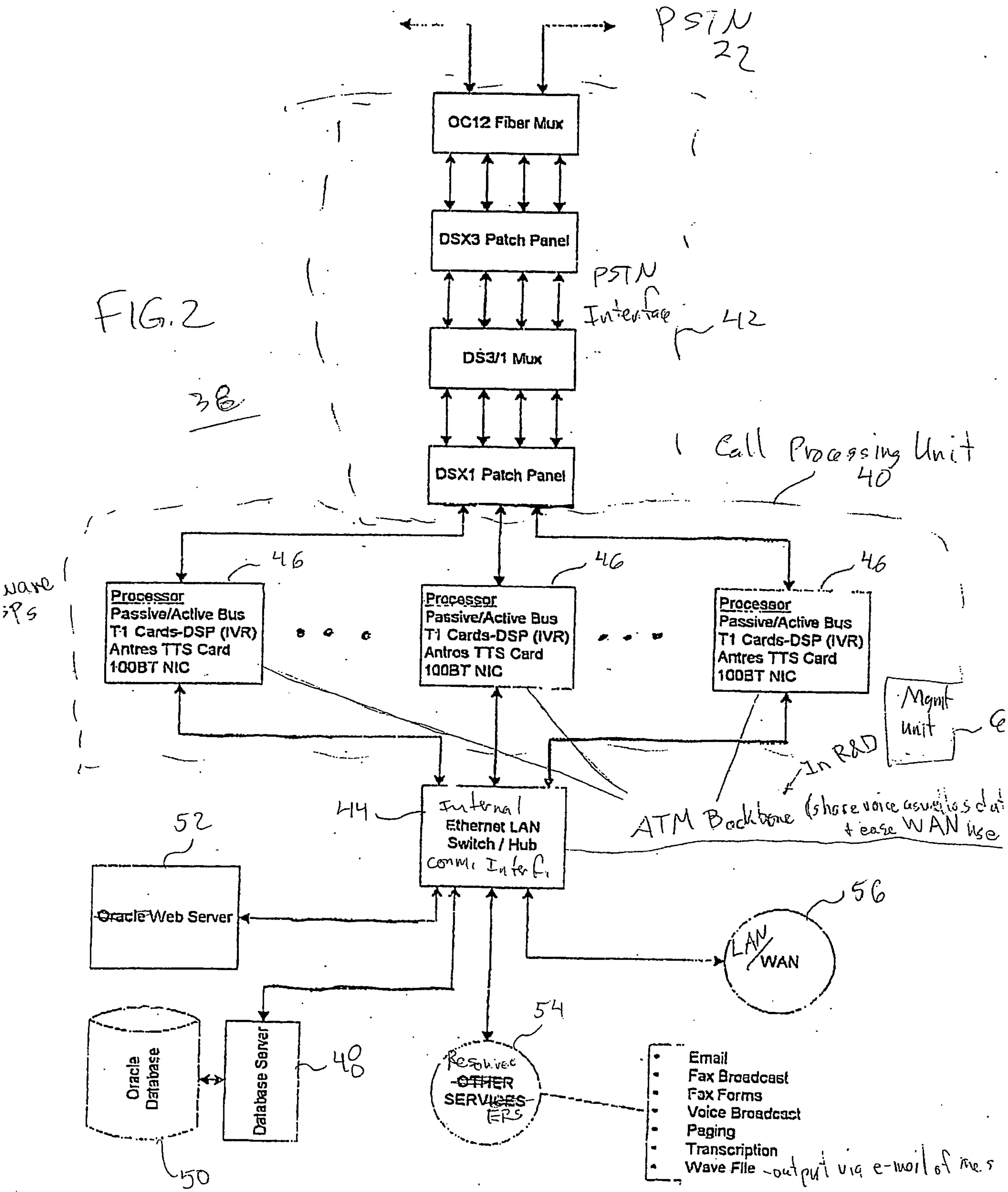


FIG. 1
PRIOR ART


PSTN
22
OC12 Fiber Mux
DSX3 Patch Panel
PSTN Interface
42
DS3/1 Mux
38
DSX1 Patch Panel
Call Processing Unit
40
46
Processor
Passive/Active Bus
T1 Cards-DSP (IVR)
Antres TTS Card
100BT NIC
Mgmt unit
In R&D
ATM Backbone (share voice as well as data + ease WAN use
44
Internal
Ethernet LAN
Switch / Hub
Comm. Interf.
52
~~Oracle~~ Web Server
56
LAN/WAN
54
Resolver
~~OTHER~~
SERVERS
Oracle Database
Database Server
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50
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Fax Forms
Voice Broadcast
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Transcription
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FIG. 2

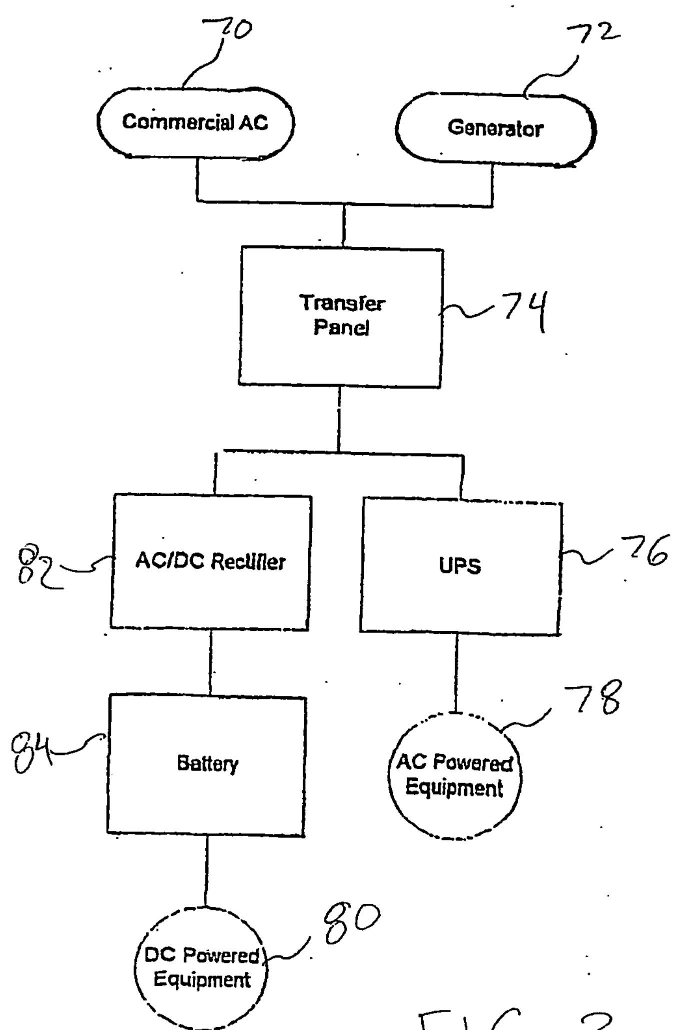
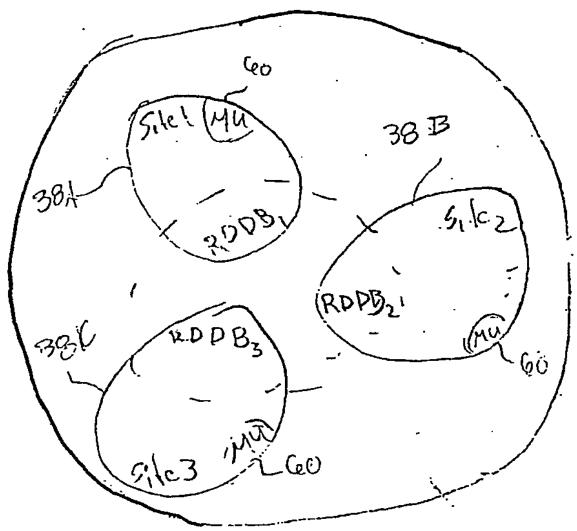

70
Commercial AC
72
Generator
Transfer Panel
74
82
AC/DC Rectifier
UPS
76
84
Battery
78
AC Powered Equipment
80
DC Powered Equipment

FIG. 3

FIG. 4


60
Site1
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38C
RDDB3
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Site3
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PCT

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(51) International Patent Classification[7]: H04M 1/64

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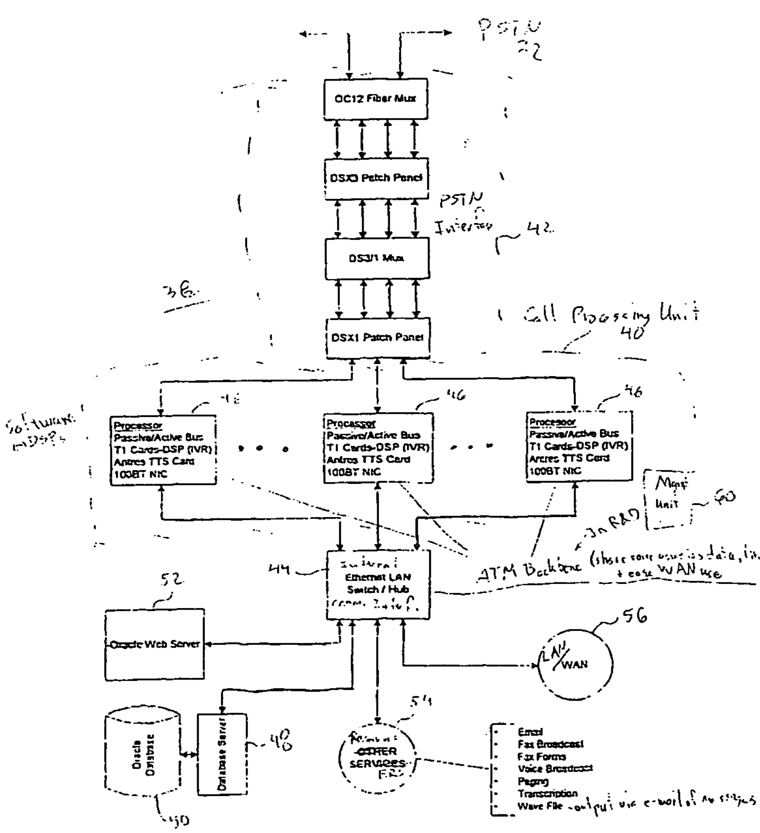

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WO 02/027708 A3

CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

with international search report

(88) Date of publication of the international search report: 8 August 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/29911

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : K04M 1/64
US CL : 379/88.07

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 379/88.07

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,327,363 B1 (HENDERSON et al) 04 December 2001, see entire document.	1--21
Y	US 6,338,130 B1 (SINIBALDI et al) 08 January 2002, see entire document.	1-21

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search 25 FEBRUARY 2002	Date of mailing of the international search report 29 MAR 2002
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